Update on Y-12 National Security Complex Activities to Recover Enriched Uranium in 2007

Becky Eddy
Y-12 National Security Complex
Oak Ridge, TN USA

Trent Andes
Y-12 National Security Complex
Oak Ridge, TN USA

Randy Dunavant
Y-12 National Security Complex
Oak Ridge, TN USA

ABSTRACT

During Calendar Year 2007, the Y-12 National Security Complex (Y-12) has completed recovery missions that resulted in the return of highly enriched uranium from Canada and several locations within the United States. These missions were performed in support of the National Nuclear Security Administration's Global Threat Reduction Initiative (GTRI) and the Department of Energy (DOE) Central Scrap Management Office for Uranium (U-CSMO). Additionally, Y-12 completed safety basis revisions for the ES-3100 shipping package which resulted in the issuance of a Certificate of Compliance (CoC) from the United States Nuclear Regulatory Commission and a Competent Authority Certificate (CAC) from the United States Department of Transportation for air transport of highly enriched uranium in the form of un-irradiated TRIGA pellets. This certification of the ES-3100 will now allow GTRI to perform recoveries of limited quantities of fresh HEU TRIGA that have been identified at several locations.

INTRODUCTION

The Y-12 National Security Complex (Y-12) continued its support of the National Nuclear Security Administrations nuclear non-proliferation goals in 2007 by completing one mission in Canada and three missions within the United States. The missions were executed in support of the Global Threat Reduction Initiative (GTRI) and the Y-12 Central Scrap Management Office for Uranium (U-CSMO).

Description of GTRI's purposes and goals have been provided in previous conference papers, so reiteration of those details will not be provided here. However, it is worthwhile to provide a brief description of the U-CSMO program. The U-CSMO was established in 1971 to provide centralized management of enriched uranium scrap. Today, CSMO locally manages and integrates uranium scrap recovery, storage, and disposition services for U.S. Department of Energy (DOE) programs, including Nuclear Non-proliferation (GTRI), Environmental Management, Office of Science, and others. The CSMO has continued to execute its recovery missions to remove uranium from a variety of facilities and locations where the material is no longer needed. Since 2003, in addition to GTRI recoveries, CSMO has executed multiple uranium recoveries from DOE sites and U.S. universities. Y-12 has the unique ability to provide safe and secure storage and serves as the designated CSMO storage facility for unirradiated uranium scrap. This centralized management of uranium provides necessary continuity and control that allows DOE / NNSA to ensure appropriate disposition of enriched uranium.

SUMMARY OF Y-12 RECOVERIES BETWEEN 2003 AND 2006

In an effort to provide a complete report on material recoveries at Y-12, a summary is provided in this section on recoveries between 2003 and 2006. The recoveries are grouped into those executed under GTRI and those under CSMO.

France (GTRI)

Two missions have recovered HEU from the CERCA (Compagnie Pour L'Etude Et La Realisation De Combustibles Atomiques) Romans facility in France. The latest mission in 2006 involved HEU fuel plates that were held in interim storage for the Belgian Nuclear Research Center (SCK•CEN). The HEU fuel was in the form of MTR plates consisting of a uranium-aluminum alloy fuel core clad in aluminum. The plates were slightly irradiated from low-power test element studies at BR2-0 zero power reactor. The HEU totaled about 15 kgU contained in 937 plates. The plates were shipped in 29 TN-BGC1 transportation packages via secure non-commercial transportation assets.

An earlier HEU removal mission involved DOE-owned HEU that was in storage at CERCA. This material was left over from Reduced Enrichment for Research and Test Reactor (RERTR) fuel development activities. The material consisted of 17 kgU of HEU in the form of uranium metal and fabrication scraps and samples. The material was returned to Y-12 in 2003 utilizing the TN-BGC1 transportation packages.

Argentina (GTRI)

The Argentine HEU originated from the Comision Nacional Energia Atomica's (CNEA) shutdown RA-2 critical assembly. The HEU was in the form of material test reactor plates (MTR) plates consisting of a uranium-aluminum alloy core clad in aluminum. The HEU was stored at the Centro Atomico Constituyentes (CAC) complex located in Buenos Aires. Over 400 plates containing 3.7 kgU were shipped in nine (9) TN-BGC1 transportation packages via commercial air transport.

Canada (GTRI)

This mission completed in 2006 recovered about 23 kg of HEU from the Atomic Energy Canada Limited (AECL) Chalk River Laboratories. The HEU was in the form of uranium oxides (from research and fuel development programs) and U-Al scraps from the fabrication of fuel elements and medical isotope targets for the National Research Universal (NRU) research reactor. Thirty-one (31) BWXT NNFD 5X22 transportation packages were utilized. Due to the quantity of the HEU, secure non-commercial transportation assets were utilized.

University of Florida (CSMO)

The HEU recovered from the University of Florida in 2006 was in the form of UF_6. The UF_6 was contained in two cylinders that were packed into a 20PF-1 over-pack. Total quantity of HEU in the form of UF_6 was 169.6 grams.

Massachusetts Institute of Technology (CSMO)

The HEU recovered from the University of Massachusetts at Lowell (UMASS-Lowell) was in the form of intact MTR research reactor assemblies. The UMASS-Lowell research reactor is a 1 MW, pool type reactor that recently converted to LEU in the year 2000. There were three fresh assemblies remaining after reactor conversion containing slightly less than a half a kg of uranium combined. The MTR assemblies were shipped in 6M-110 transportation packages.

State University of New York at Buffalo (CSMO)

Material recovered from the State University of New York (SUNY) at Buffalo included 1.3 kg HEU and 26.7 kg LEU. The HEU was in the form of oxides (standards), alloys (foils and samples), and an over-sized, slightly irradiated fission plate. The LEU was in the form of UO2 as rods, pellets, or standards. The SUNY-Buffalo research reactor was originally constructed in 1961 as a swimming pool reactor fueled with aluminum-clad MTR plate type assemblies. Beginning in 1963, the reactor was reconfigured to a PULSTAR (Pulsed Training Assembled Reactor) fueled with assemblies constructed of 6% enriched UO2 sintered pellets clad in Zircaloy-2 tubes. The PULSTAR operated until 1994. The HEU and LEU were shipped to Y-12 in 6M and 7A transportation packages. The fission plate was sectioned and canned prior to shipping.

SUMMARY OF Y-12 RECOVERIES IN 2007

This section includes a summary of the most recent recoveries executed in 2007. The recoveries are again grouped into those executed under GTRI and CSMO programs.

Canada (GTRI)

The 2007 Canadian mission again involved the recovery of U.S. origin HEU from AECL facilities at Chalk River. The HEU was again in the form of uranium oxides (from research and fuel development programs) and U-Al scraps from the fabrication of fuel elements and medical isotope targets for the National Research Universal (NRU) research reactor. The total amount of recovered material was approximately 19 kg of HEU. Twenty (20) BWXT NNFD 5X22 transportation packages were used to return the HEU to Y-12.

Iowa State University (CSMO)

The HEU recovered from the Iowa State University, located in Ames, Iowa, was in the form of two U metal circular disks, approximately 2 inches in diameter and 0.02 inches thick. The total ^{235}U in both the disks amounted to 36 grams, with each disk at approximately 93%. The disks were packaged within a single convenience can and, subsequently, the can was loaded into a DOT Specification 6M transportation package.

University of Florida (CSMO)

This CSMO mission included the recovery of both HEU and LEU from the University research reactor facility. The HEU was in the form of a U-metal foil. The HEU foil contained approximately 43 grams of ^{235}U at 93% enrichment. The LEU was in the form of numerous small U-Al alloy melt samples along with four MTR type fuel plates. The LEU melt samples contained a total of approximately 28.5 grams of ^{235}U at 19.75% enrichment. The LEU MTR plates contained a total of approximately 56 grams of ^{235}U at 19.75% enrichment. The HEU material was packaged within a UN1A2 container and the LEU material was packaged within a single DOT Specification 6M-110. Commercial transportation was utilized.

Texas A&M (CSMO)

The recovery of HEU from the Texas A&M University research reactor was in the form of one unirradiated TRIGA fuel element (U-$ZrH_{1.6}$ fuel meat), containing 112 grams of ^{235}U at 70% assay. The unirradiated TRIGA element was a TRIGA Fuel Follower Control Rods (FFCR). A UN1A2 package was used to transport the TRIGA fuel. Prior to shipment, the TRIGA fuel elements were cropped to remove the U-$ZrH_{1.6}$ fuel pellets.

Table 1. Summary of Y-12 U.S. HEU Recovery Missions 2003 – 2007 (to-date).

RECOVERY PROJECT	DATE	LOCATION	QUANTITY	FORM	SPONSOR PROGRAM
CERCA Romans Facility	2003	Romans, France	17 kg HEU	Uranium Metal	GTRI
University of Massachusetts at Lowell	2004	Lowell, Massachusetts	0.45 kg HEU	MTR assemblies	CSMO
University of Buffalo - SUNY	2005	Buffalo, New York	1.3 kg HEU 26.7 kg LEU	Oxides, Alloys Miscellaneous UO_2	CSMO
Belgian Nuclear Research Center	2006	Romans, France	15 kg HEU	MTR plates	GTRI (Gap)
Argentine Comision Nacional Energia Atomica	2006	Beunos Aires, Argentina	3.7 kg HEU	MTR plates	GTRI (FRRSNF)
University of Florida	2006	Gainseville, Florida	0.1696 kg HEU	UF6	CSMO
Atomic Energy Canada Limited	2006 2007	Chalk River, Ontario	23 kg HEU 19 kg HEU	Oxides, Alloys Oxides, Alloys	GTRI (Gap) GTRI (Gap)
University of Florida	2007	Gainseville, Florida	0.043 kg HEU 0.084 kg LEU	U-Metal MTR plates	CSMO
Iowa State University	2007	Ames, Iowa	0.036 kg HEU	U-Metal	CSMO
Texas A&M University	2007	College Station, Texas	0.160 kg HEU	TRIGA FFCR	CSMO

COMPLEMENTARY EFFORTS AT Y-12 SUPPORTING MATERIAL RECOVERIES

In order to continue to safely and efficiently support material recoveries, efforts are continuously made at Y-12 to improve the methodologies and mechanisms required to execute these missions. This section describes recent activities undertaken at Y-12.

New Shipping Packages

ES-3100

The ES-3100 shipping package is a U.S. Department of Energy owned and U.S. Nuclear Regulatory Commission certified type B fissile package designed and operated by Y-12. The ES-3100 package is a drum-like container that is approximately 43 inches in height and 19 inches in diameter and is composed of an outer assembly and an inner containment vessel. The outer assembly consists of a reinforced stainless steel, standard mil spec 30-gal drum with an increased length. The containment vessel is approximately 32 inches in overall height (31 inches

usable internal length) and 5 inches in overall diameter and is constructed of 304L stainless steel. The maximum gross weight of the package, including contents, is 190.5 kg (420 Ib). The ES-3100 was designed to ship bulk HEU in the form of oxide (UO2, UO3, or U3O8), uranium metal and alloy in the form of solid geometric shapes or broken pieces, uranyl nitrate crystals. The initial revision of the ES-3100 Certificate of Compliance (CoC) was issued in 2006 and authorized these contents for ground/vessel transportation. Recent efforts have focused on revising the allowable contents of the ES-3100 to authorize air transport of fissile materials, primarily to support material recoveries around the globe. Revision 6 of the ES-3100 was issued in August of 2007 and authorizes air transport specifically for unirradiated HEU TRIGA fuel elements. The U.S. Department of Transportation Competent Authority Certificate (CAC), Revision 1, was subsequently issued following the CoC to allow for international shipments.

ES-4100

The ES-4100 is a proposed shipping package that is currently being designed by Y-12 for the replacement of the 6M-110 container. The ES-4100 is being developed primarily for the shipment of full length fuel assemblies for research and test reactors. The ES-4100 is very similar to the design of the ES-3100 with the exception of 4 5 inch diameter inner containment vessels per drum (1 for ES-3100) and a 58 inch inner containment vessel usable length (31 inches for the ES-3100). The maximum gross weight of the ES-4100 is expected to be approximately 2000 lbs (88 lbs per inner containment vessel). The ES-4100 is being designed to be compatible to the ES-3100 tooling allowing for existing ES-3100 users to easily transition into using the ES-4100.

Formalization of Mission Processes

Special Nuclear Material (SNM) recovery missions involve a varied assortment of material types and forms which require special attention to handling, packaging and transportation from locations around the world. Special attention must be paid to all activities leading to a safe and secure recovery operation. Numerous technical and administrative hurdles must be addressed prior to and during execution.

Characterization and Packaging

Upon identification of SNM as a candidate for return, formal characterization of the material is required prior to transportation and receipt at the receiving facility. The characterization process at Y-12 is documented on the CSMO Scrap Declaration. The Scrap Declaration document is a series of forms that, when completed, describe the material, detail the actual or proposed packaging configuration and provide shipper assurances that the material has not been declared waste. The Scrap Declaration requires detailed material and packaging descriptions which are typically completed by the shipping facility. The material description includes materials of construction, dimensions, weights (overall, element, and isotope), item listing (plate unique identification numbers), dose rates, and contamination levels. The package description describes the transportation package, loading configuration of the SNM to be shipped, weights (gross, net, and tare), and dose rates (contact and 30 cm). Due to the complexity of the Scrap Declaration

and the need for accurate data, completion often requires a cooperative working process between Y-12 and the shipping facility.

Materials recovered from external sources must meet Y-12 acceptance criteria for receipt, handling, storage, and processing. The information documented in the Scrap Declaration serves as the basis for the Y-12 review process. Focused areas of review include nuclear criticality safety, radiological safety, material control & accountability, facility operations, and the HEU disposition office.

Environmental Documentation

The National Environmental Policy Act (NEPA) requires a thorough review of all governmental actions that could adversely impact the environment. Y-12 has the necessary environmental documentation in place to support enriched uranium recovery missions from around the globe. The Y-12 Site-Wide Environmental Impact Statement (SWEIS) and other related tiered documents which have been in place for a number of years support the recovery missions. The SWEIS and tiered documents include portions which discusses the Y-12 nuclear nonproliferation activities such as material recovery actions. In 2005, an Environmental Assessment (EA-1529) was issued to support recovery from four specific locations. The focus of EA-1529 was to address the NEPA requirement to analyze impacts of crossing Global Commons. In 2006, a Supplemental Analysis (SA) to the SWEIS was issued to address the Global Commons issue without specificity to shipment origination point or mode. The SA provided a bounding analysis under which shipments could be made to Y-12 from various locations. The Y-12 SWEIS allows the material return from foreign and domestic locations of U.S. and includes non-U.S. origin materials.

Contracts

Y-12 has recovered material from foreign and United States sources using various contractual and agreement mechanisms. For United States returns, these materials are brought back under the CSMO program using NNSA funding and only title transfer documents are required. In the case of the return of foreign HEU, NNSA may have an agreement with the foreign entity and NNSA funding is used for the return or NNSA and the organizational entity which is returning the HEU sign a Work-for-Others (WFO) contract for the return of the material. The WFO contract would include quantity and form of material to be returned, cost of recovery, material credits where applicable, and other legal controlling factors. These contracts are usually with high-income countries and it is in their benefit to return the HEU in order to reduce security and storage costs and to recover some of the value of the HEU that they purchased. Use of these contracts is very supportive of the GTRI mission because they facilitate the removal of HEU from commercial commerce while minimizing NNSA funds for the removal.

Depending on the quantity and form of HEU returned, equivalent LEU credits may be offered by NNSA as an incentive to participating foreign entities in exchange for the return of HEU. The quantity of applicable LEU credits is based on the net value of the returned HEU. Net value of the returned HEU is based on the current market value of the LEU product to be derived from the HEU minus disposition costs. Typical disposition costs include the cost of the down-blending diluent and the costs for the required chemical processing, blending, and transportation.

The kilograms of available credits may then be calculated by dividing the determined net value of the returned HEU by the seperative work unit (SWU) and feed component costs of the LEU that would otherwise be purchased.

Disposition

NNSA utilizes the Defense Nuclear Nonproliferation Fissile Materials Disposition Program (NA-26) to provide an avenue for disposition for the HEU recovered under GTRI and CSMO programs. NA-26 has managed the down-blending of U.S. HEU to LEU for the past 10 years. Y-12 serves as the Lead Laboratory for NA-26 HEU disposition activities. As of the end of January 2007, NA-26 had down blended approximately 84 MT of HEU. Materials recovered under GTRI, will as a matter of policy, be made available for down-blending to LEU and fed back into the fuel cycle as either commercial or research reactor fuel (assuming the material is of a recoverable form). Most of the GTRI recoveries to Y-12 are in quantities of kilograms as compared to the metric tons that are being handled by NA-26. Thus, inclusion of the GTRI materials into existing NA-26 projects is generally achievable and can be done at a small incremental cost to the program.

Execution

The execution phase of a recovery project begins with the initial site visit to start the characterization process. NNSA and receiving facility (Y-12) technical staff will meet with the facility representatives to gather drawings, accountability records, perform inspections, etc. The technical staff will also perform a facility assessment of capabilities for handling different transportation packages. During this visit, or possibly a subsequent visit, dose rate measurements are obtained, materials are weighed and dimensionally checked, and confirmation measurements using non-destructive analysis equipment are performed. During the actual retrieval, Y-12 staff will be on-hand to provide technical assistance during loading operations, observe repackaging of the material into approved storage and transportation containers, and apply tamper indicating devices (TID's). In some instances, the staff will accompany the material and its conveyance in transit.

SUMMARY

Nuclear non-proliferation continues to be a primary focus area for Y-12. In 2007 Y-12 again performed recovery missions supporting both GTRI and CSMO programs by repatriating approximately 20 kg of HEU. In addition to recoveries, Y-12 completed activities that resulted in the certification of the ES-3100 transportation package for air transport of TRIGA HEU. The certification of the ES-3100 for TRIGA HEU will support an important recovery mission that should be executed by the end of 2007.